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Roots and Tubers Value Chain Development and Food and Nutrition Security - PNG

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Roots and Tubers Value Chain Development and Food and Nutrition Security

Lessons for Papua New Guinea from the World Congress on Roots and Tuber Crops, China, 18–22 January 2016

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List of acronyms

ACIAR	Australian Centre for International Agricultural Research
AusAID	Australian Agency for International Development
CIAT	International Centre for Tropical Agriculture
CIP	International Potato Centre
CIRAD	Agricultural Research for Development
DAL	Department of Agriculture and Livestock
DPI	Department of Primary Industry
FPDA	Fresh Produce Development Agency Ltd
GDP	Gross domestic product
IITA	International Institute for Tropical Agriculture
IPGRI	International Plant Genetic Resources Institute
NARI	National Agriculture Research Institute
NGO	Non-governmental Organisation
PAPGREN	Pacific Agriculture Plant Genetic Resources Network
PLB	Potato Late Blight
PNG	Papua New Guinea
R&D	Research and Development
RTCs	Root and Tuber Crops
SPC	Secretariat of the Pacific Community
TLB	Taro Leaf Blight
WCRTC	World Congress on Roots and Tuber Crops

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Executive summary

Root and tuber crops (RTCs) are important dietary staples and food security crops for the people of Papua New Guinea (PNG) and Pacific Islands. However, the productivity of RTCs remains almost static, reflecting the agro-technological and socio-economic constraints to production, while consumption is challenged by high imports of cheap cereal products. Research and development (R&D) on RTCs receives little attention compared to other established commodity crops like coffee, oil palm, coconut and cocoa.

A change in government policies on agricultural development, trade and research is required in order to give adequate attention to RTCs and support their development. Adopting a value chain approach, driven by market demands for fresh and processed RTCs may provide the answers.

Introduction

Root and tuber crops (RTCs) are important traditional food sources among the people of Papua New Guinea (PNG) and Pacific Island countries. Their contribution to food security is well recognised. Traditionally, sweet potatoes (*Ipomoea batatas*), taro (*Colocasia esculent* and *Xanthosoma*), yams (*Dioscoreaspp*.), sago *(Metroxylonspp*.) and bananas were the staple foods providing much of the calorific requirements of the PNG diet. However, over the last 4 decades, sweet potato has become more dominant throughout PNG (Bourke and Allen, 2009), particularly in the lowlands. The switch from taro, which was once the traditional staple in the lowlands, was mainly due to the occurrence of taro leaf blight (TLB) infestations. Other RTCs gaining popularity in many parts of the country include Irish potato, yam and cassava.

Most RTCs are primarily grown for human consumption and a certain amount is fed to livestock, but very little is processed. Yields of RTCs in the Pacific region are generally low and below production potential as indicated by farmers' fields and experimental results (Lambert, 1979). Although RTCs are the traditional staple food throughout PNG and the Pacific region, there has been a significant shift in consumption towards imported cereals and cereal products derived from rice, wheat, barley and maize, particularly in urban centres. The decline in productivity and consumption of RTCs reflects both the agro-ecological and socio-economic constraints.

This paper discusses the status of RTCs in PNG, the national plans and regional initiatives for their development. Also highlighted are the challenges faced by the National Agriculture Research Institute (NARI) in developing RTC initiatives, and lessons learnt from the 2016 World Conference on Root and Tuber Crops (WCRTC) held in China.

Sweet potato

In PNG, 83% of food energy consumed is derived from locally produced crops. Sweet potato alone accounts for 66% of calorie requirements, while imported cereals provide less than 15% of food energy (Bourke, 2009). Approximately 60–75% of sweet potato grown is primarily for human consumption in its raw form, while the remainder is fed to pigs and other livestock animals (Chang and Kewa, 2014). The total land area devoted to sweet potato production in the country in 2013 was estimated at 122,000 ha, yielding approximately 600,000 t of fresh root (FAO, 2013). PNG is considered the second largest centre of genetic diversity for sweet potato in the world. Around 5,000 varieties are grown, of which 1,600 have been collected and maintained by NARI (Yen, 1974; Bourke, 2009b). In PNG, sweet potato yields are either declining or almost static and there is tremendous scope for yield improvement (O'Sullivan *et al.,* 1997). Bourke and Vlassek (2004) estimated sweet potato yields to be at 15 t/ha in the PNG highlands and 13 t/ha in the lowlands, substantially higher than the Food and Agriculture Organization's (FAO) estimates. Sweet potato yields can be as high as 30–35 t/ha, as in Australia, Israel, and Egypt (CIP, 2000).

Although sweet potato has gained a dominant status in the region in terms of its contribution to overall energy intake, yield remains relatively low and constant. The main factors limiting the expansion of output include the lack of suitable varieties, pests, diseases and decline in soil fertility. The traditional production system has not been geared to meet market demand, and the commercial smallholder is constrained by high costs of production, transportation

and marketing (Chang and Kewa, 2014). Sweet potato is also less profitable than some export crops due to its bulky, high weight-to-value ratio and highly perishable nature. Long distance marketing for sweet potato is challenging, and demands resources and chain coordination (Chang *et al.,* 2008). Marketing costs in PNG can account for up to 75% of the total costs, while postharvest losses can be as high as 30–50% when the product arrives in Port Moresby from the highlands; especially if there have been substantial shipping delays (Irving *et al.,* 2011). The availability of cheaper, imported cereals and shifts in consumer demand and consumption, make marketing difficult. These are common constraints for the development of RTCs and need to be considered for guiding investments and research to improve production and processing. Venturing into niche markets for sweet potato should be underpinned by market research.

Sweet potato and other RTCs have been relatively neglected in government policy and by research and extension despite the efforts of R&D organisations such as NARI and Fresh Produce Development Agency Ltd (FPDA). Sweet potato is the only crop that receives much research attention and funding through a wider network of regional and international partners. Within the framework of its strategic implementation plan (NARI, 2013), NARI has carried out numerous varietal and agronomic research projects in the last 2 decades. These projects have resulted in the release of approximately 20 improved varieties with traits including high yielding, early maturation and drought tolerance. Improved production techniques have also been developed which a focus on: (a) maintenance and utilisation of genetic resources for crop improvement and selection of suitable varieties; (b) improved crop agronomic and management practices; (c) improved soil management practices in sweet potato-based cropping systems; (d) pests and disease management strategies and supply of quality pathogen tested planting materials; and (e) improved postharvest handling and processing. The Australian Agency for International Development (AusAID) via the Australian Centre for International Agricultural Research (ACIAR), supported most of the R&D activities on sweet potato in PNG in terms of both finance and technical assistance. Short training courses and graduate programs have also been facilitated to strengthen research capacity in such areas as the sweet potato pathogen tested seed system, and food processing technology.

In addition to the R&D work by NARI and FPDA, other players such as the PNG Department of Agriculture and Livestock (DAL), various tertiary institutions and NGOs, are important partners in the development of sweet potato in the country. To improve activities at all levels of the value chain, innovations should be driven by market demand and pursued in a more holistic manner.

Taro

For decades, taro (*Colocasiaesculenta* and *Xanthosoma spp.)* has been the third most important indigenous staple in PNG, after sweet potato and bananas. It is estimated that 436,000 t of taro are produced annually on an area of 77,000 ha (FAO, 2000). There is archaeological evidence of taro cultivation dating as far back as 9000 years ago in the Kuk/Baisu area of the Western Highlands Province (Golson, 1977). PNG now has the world's largest genetic diversity of taro (about 800 different cultivars) (FAO, 2009a).

As in many of the Pacific Islands, taro has a prominent position in PNG society, not only as a source of dietary carbohydrate but also for ceremonial purposes. It is the staple food in

lowland and intermediate altitude areas where rainfall is well distributed throughout the year; particularly in the Gazelle Peninsula, parts of Central and East Sepik, Madang, Milne Bay, Morobe, Northern, West Sepik and Western Provinces (Star Mountains). However, recent estimates indicate the drop in quantity to only 270,000 t and the land area previously under production has been reduced by almost half (FAO, 2013).

In the lowland regions, taro is ready for harvest in 7–9 months, but maturity for harvest in the highland regions may not come until 15–18 months after planting. Average yields are estimated to be 5–10 t of fresh corm per hectare. Virtually all the harvested taro is handled, transported and utilised as fresh corm.

The marked decline in taro production in recent years has been due essentially to the taro beetle *(Papuanaspp*.), TLB *(Phytophthoracolocasiae)*, the availability of imported food substitutes (cereal products) and the greater ease of producing other crops such as sweet potato. Taro is more expensive than sweet potato, yam and cassava, partly because of these production constraints. However, it is still the preferred food item over other RTCs. The prevailing occurrence of the aforementioned pests and diseases does not allow for commercial export due to quarantine restrictions but this has not crippled local production. This may be due to the genetic diversity of taro in PNG which has a stabilising effect on the industry.

Research has been progressing to address some of the constraints indicated above. Much of this research is centred in the Morobe Province at the Bubia NARI Research Station and at the University of Technology. Previous R&D activities focussed on: (a) collection, characterisation and conservation of taro genetic resources; (b) utilisation of genetic resource in breeding (developing TLB resistant varieties); (c) agronomy and crop management practices; and (d) management of TLB, taro beetle and viruses. At present, R&D efforts by NARI are diverted to varietal development and selection of varieties for improved yield, culinary acceptability; and post-harvest handling for marketing. A modest amount of processing for value added products has been done, while maintenance of taro genetic resources via *ex-situ* and *in-vitro* is routine.

An inclusive study on the crop to target important research gaps is not feasible due to the limited government financial support to R&D institutions. Many of the previous taro studies were jointly funded by external aid agencies such as AusAID via ACIAR, the International Plant Genetic Resources Institute (IPGRI), Pacific Agriculture Plant Genetic Resources Network (PAPGREN), Secretariat of the Pacific Community (SPC) and the European Union in collaboration with national and international partners. Redirecting research attention and funding to RTCs could revitalise taro production.

Cassava

Cassava (*Maniot esculenta*) is one of six staple crops that provide approximately 6–8% of food energy in PNG with an estimated annual production of 272,000 t (Bourke, 2005). Land area devoted to cassava in PNG in 2012 was around 12,000 ha and the average yield ranged from 8–12 t/ha (FAO, 2013). Cassava is not produced commercially in PNG because of its bulk and perishability. It is usually consumed fresh where it is locally grown. Cultivated as a subsidiary crop with other food crops such as sweet potato, taro, yam, banana, maize, peanut and beans, cassava often forms a life-saving resource during periods of famine.

However, although cassava adapts to a wide range of environments, it is only considered an important crop in the lowlands and dry areas of the highlands. Cassava's increasing importance for food, animal feed and industrial uses has spurred rapid expansion of its production in recent times. Moreover, the significance of cassava in many parts of PNG has increased due to the drought experienced in 1997/98 and more recently in 2015/16. Cassava production has now gained momentum compared with other important staple crops such as sweet potato, taro and yam, mainly because of its ability to tolerate drought and produce stable yields in soils of low fertility. Poor soil conditions in PNG are thought to have been imposed by the improper and over-use of scare land resources. Though underutilised, cassava provides a new potential for food and income security in PNG in the face of climate change.

NARI has taken a leading role in various cassava R&D projects in the country, particularly in genetic resource management, crop improvement, agronomy and processing. NARI released nine drought tolerant and low cyanide cassava varieties in PNG in 2003, which form the basis of current cassava research. The need to select varieties with high dry matter content is eminent given the growing interest in cassava processing. Hence, the NARI cassava breeding programme is aimed at developing suitable varieties for fresh and dry root production purposely for processing. Research on cassava processing and product development for human, animal and industrial uses was initiated by the NARI Food Processing team at Bubia, Lae. DAL and the South Pacific Brewery signed an agreement in 2015 to set up a cassava project in Erap, Morobe Province, to obtain cassava starch and use it in a trial for the production of alcohol. Yet, there are still research gaps in the areas of efficient crop breeding tools, crop agronomy and management, post-harvest handling, processing and the development of various end products.

Yam

Yams (*Dioscoreaspp*.) are very important in PNG, particularly in the Trobriand Islands (Milne Bay Province) where they are used in traditional ceremonies. Milne Bay Province is the leading producer of yams in PNG, other provinces include: East Sepik, Sandaun, Madang, New Ireland, Western, Central and Morobe Provinces. Yams are a secondary staple in highland areas with a marked dry season. The three common species of yam {(greater yam (*D. alata*), lesser yam (*D. esculenta*) and potato yam (*D. bulbifera*)}, provide a staple or co-staple food in PNG. A study by Bourke and Allen (2009) stated that greater and lesser yams are widely cultivated across the region, and provide an important food resource for 17% of rural villages. Greater yam is grown up to 1,900 m above sea level and lesser yam up to 1,550 m, but production for both species mostly occurs in the lowlands. The average yields recorded for greater and lesser yams is approximately 13 t/ha and 15 t/ha respectively. White yam (*D. rotundata*) is an African species introduced into PNG in 1986; its popularity is growing due to its wider adaptation across different agro-ecologies in PNG and increased yield compared to other indigenous species. In an evaluation at NARI Bubia near Lae, recorded yields were 61 t/ha.

Total yam production seems to have increased between 1960 and 2000 (120,000 and 250,000 t respectively), but its contribution as a proportion of total staple food energy has declined from 9% to 5% over this period (Bourke and Allen, 2009). More recent statistics from 2012 show that PNG produced roughly 345,000 t of yam, ranking it ninth in the world

for yam production (FAO, 2013). The decline in yam as a staple food source could be due to its waning social status in traditional societies as a result of Western influence. Additionally, the high labour and production inputs, shortage of fertile land and other technical constraints could be impacting its contribution as a food energy resource.

Despite their dietary and cultural importance, yam remains under-researched in PNG with studies only having been carried out on cultivar evaluation and crop agronomy. Research institutions responsible for R&D are handicapped due to limited access to research grants. The general decline of yam production and consumption could be halted if research were to address important limitations such as the shortage of clean planting materials; degradation of tuber quality by nematodes, pests and diseases; high labour requirements; and inadequate supplies of staking materials, as reported by Risimeri (2001).

Despite limited funding, NARI have collected and characterised many native *Dioscorea* species and maintained them at their Bubia and Laloki research stations in the field and the laboratory. Through species evaluations, NARI is also at the forefront of supplying quality planting materials to farmers and other stakeholders in PNG, while also facilitating exchange for genetic resources with other countries. NARI's R&D programmes are also focussing on a pest management strategy for anthracnose disease and nematode infestations, which deter productivity and compromise produce quality in PNG.

Irish potato

Irish potato *(Solanum tuberosum)* in PNG is grown by 16% of the rural population (Bourke and Allen, 2009). Production is mostly restricted to the five highland provinces, particularly in high altitude locations (1,500–2,800 m.a.s.l). Irish potatoes are an important cash crop in the highland provinces of PNG. Commercial trade by 1980 had reached 15,000 t annually with a total value of US$2.8–4.2 million (ACIAR, n.d.), while in 2004 estimated production reached 18,000 t (Bourke and Vlassak, 2004). This trade involved smallholders, many of whom also rely on potato as a food staple and income source.

Irish potato was introduced into the highlands in the 1930s. The PNG Department of Primary Industry (DPI) has introduced 37 cultivars for evaluation since 1954 (Graham, 1976). A mixture of cultivars is grown but the industry is now based on production of the cultivar *Sequoia* using certified seed. With disease-free seed and good soil fertility conditions, yields are high and exceed that of any other RTC. Potato production increased for both subsistence and sale after 1970, but declined following an outbreak of Potato Late Blight (PLB) (*Phytophthorainfestans*) in early 2003. The disease outbreak led to the almost complete destruction of the crop in the highlands, and the near collapse of what had been a thriving potato industry. This strain of fungal disease was found in other potato-growing regions throughout the world but not in PNG prior to the outbreak. The highlands climate is ideal for PLB making control regimes vital, and also expensive.

Management of PLB in PNG was initiated in late 2003, led by NARI in partnership with Victoria Department of Primary Industries, Australian Corporative Research Centre for Tropical Plant Protection, International Potato Center (CIP), FPDA and the PNG Cocoa and Coconut Institute. The fight against PBL was aimed at: introducing, multiplying, evaluating and deploying late blight resistant potato clonal material into PNG; and developing safe and

cost effective integrated late blight management strategies for existing and new potato cultivars.

Positive progress has been seen in the development of cost effective and safe fungicides for PLB control which were recommended for farmer use in 2009. Moreover, six out of the 66 Irish potato varieties introduced from Australia and CIP Peru were tested, selected and disseminated in PNG in 2010. These varieties indicated a high level of resistance to PLB accompanied by good yield, agronomic and consumer preferred traits. Lack of seed potatoes is always a critical factor preventing farmers from participating in potato production. Thus, a clean (certified) seed system via tissue culture was established and implemented jointly by NARI and FPDA in Aiyura and Tambul Research Stations. Since then, farmers have been able to consistently access quality seed, resulting in the PNG potato industry doubling in its annual production when compared to the record of 2003 (approx. 700 t) (FAO, 2013). As a result, the PNG Government has recently lifted a ban on imported potato to encourage local production.

Specialised area of expertise

Working as a plant breeder, my primary role is to plan, implement and monitor breeding programs in NARI Highlands Regional Centre, Aiyura. The main focus of NARI's crop improvement program is to improve the genetic potential of staple PNG RTCs for food and nutritional security through plant breeding. I am tasked with the challenge of improving the genetic potential of sweet potato and cassava crops through hybridisation, and selection of elite varieties for dissemination to PNG's farming communities. Our core activities include:

1) Development of improved early maturing and high yielding sweet potato varieties with wider adaptability
2) Development of orange-fleshed sweet potato varieties rich in vitamin A
3) Varietal development of cassava genotypes for high dry root yield and processing qualities.

Our breeding approach combines aspects of classical genetics, conventional breeding and biotechnology in order to accomplish tasks in a timely and resource efficient manner.

Over the last 5 years, we have generated approximately 50,000 sweet potato and 300 new cassava lines, with most of the on-station varietal evaluation trials concluding last year. From these studies, the following was identified:

1) Six improved early maturing and high yielding genotypes with average yield between 21–30 t/ha of fresh root at harvest in 120 days. The dissemination of these elite genotypes to farming communities will follow the completion of genotype by environment (GxE) multi-location trials which will start in 2016.
2) Eight promising orange-fleshed genotypes with potentially high beta-carotene (precursor of vitamin A) with average fresh root yield of 20–32 t/ha. Vitamin A content was estimated using HarvestPlus Carotenoid Colour Strips. A follow up chemical analysis via high performance liquid chromatography (HPLC) will be done to confirm vitamin A status of these selected materials. Identification of orange-fleshed sweet potato varieties rich in vitamin A will be disseminated and promoted in partnership with health, nutrition and

education departments as a way of alleviating vitamin A deficiency in target PNG communities.

3) 10 improved cassava genotypes with high fresh (24–38 t/ha) and dry (11–16 t/ha) root yield.

These materials will formally be released by NARI within the next 2 years for cultivation in PNG.

In order for us to successfully improve the genetic potential of RTCs, wider consultations between farmers, development partners (DAL, FPDA), NGOs and community based organisations (CBOs), are sought through the Regional Agriculture Research and Development Advisory Committee meetings. Such consultations should take place before breeding priorities for selected crops are implemented, so that research outcomes can directly address the needs of farmers. The NARI Research Committee plays a key role in developing and coordinating RTC R&D activities. Farmers, NGOs and CBOs are important partners in regards to multi-location varietal trials, where they are actively involved in the evaluation, selection and dissemination of RTC varieties. To promote awareness and uptake of improved crop varieties, the established networks of relevant stakeholders (such as farming groups, church groups, NGOs, CBOs, DAL, FPDA, etc.) should be utilised to disseminate the information.

Lessons from the China WCRTC conference

Note: *Information contained in this section of the report depicts the summary highlights from conversations and interviews on media stages, plenary sessions and various presentations (oral and posters) during the 2016 WCRTC.*

The first WCRTC held in 2016 in Nanning, China, promoted dialogue between RTC researchers and private sector farmers, and facilitated discourse about more than 23 topics on RTCs. It also provided a forum for experts in science, technology and the private sector to discuss the best methods for RTC enhancement, and identified the solutions to major problems in the relevant value chains. Promotion of RTCs in building more diverse and sustainable agri-food systems is necessary to ensure food security among dependant producers and consumers around the world. In order to realise this, a value chain approach driven by appropriate policies is imperative to support RTC-based agri-food enterprises, with the integration of core end-user oriented research agendas in the main development pathways.

Important areas of research highlighted in the 2016 WCRTC were the positive impact of advanced genetic improvement, and the challenges encountered in providing options for future R&D consideration. Emphasis was placed on improving breeding strategies for RTCs to enhance genetic resources and quality seed. Other areas addressed for R&D included development of resilient crops in the face of climate change, and adding value to nutrient rich foods.

Strategy #1: Enhanced genetic resources

This strategy proposed to develop and apply tools and systems such as molecular breeding and marker assisted selection for the improvement of RTC breeding and shortening cycle

selection. Enhanced genetic resources will add value to gene banks through conservation research, linking genes or traits to gene bank accessions, and increased characterisation of diversity. All of which will guide varietal and trait development for greater uptake and impact.

Plate 1: Guangxi Cassava Germplasm Repository is an important research base for the collection, identification, evaluation and innovative utilisation of cassava germplasm. The repository plays an important role in cassava research, popular science education and therefore promotes the cassava industry in China.

Strategy #2: Productive varieties and quality seed

Under this strategy, recommendations are put forward to develop improved RTC varieties with novel breeding targets, methods and processes that will be applied to accelerate genetic gains for key traits across all RTCs. The use of systematic selective breeding complemented by genetic modification and genomic selection has proven to be a useful alternative method for the introduction of new desirable traits with improved outputs and efficiency. Several prominent research institutions worldwide under CGIAR, such as the International Centre for Tropical Agriculture (CIAT), CIP, International Institute for Tropical Agriculture (IITA), and Agricultural Research for Development (CIRAD), are leaders in this area and collaborate with various other R&D partners to harness the genetic potential of RTCs.

Development of new varieties needs to consider the use of participatory, gender-sensitive research tools to understand the traits and criteria that stakeholders deliberate when adopting or rejecting varieties. End-user intelligence will guide breeding processes to ensure that novel breeding targets are integrated. This strategy also aims to develop and make available good-quality planting materials of diverse, advanced RTC varieties that meet the needs and preferences of value chain actors.

Strategy #3: Resilient crops

The strategy for resilient crops seeks to close the yield gaps of RTCs vulnerable to biotic and abiotic threats; monitor pest and pathogen movement; assess risks and design responses for new threats. It also aims to develop climate-resilient and ecologically sustainable production systems, thereby strengthening food security and improving natural resource quality and ecosystem service provision.

Strategy #4: Nutrient rich food and added value

This strategy aims to harness the nutritional potential of RTCs more widely, expand their utilisation and add value through postharvest innovation. Researchers are expected to

collaborate with breeders to design and develop more nutrient-dense RTCs through biofortification, and promote other preferred traits of the market. Market development research will strengthen demand-pull and accelerate uptake of nutritious and profitable varieties.

It is anticipated that this strategy will also address the perishable nature of RTCs through improved storage, transportability and diversified use. In addition, it will promote gender-equitable development and youth empowerment among activities of the value chain. The strategy also intends to develop improved methods for postharvest processes, integrating technical, economic and environmental aspects to enhance the sustainability and profitability of products.

Plate 2: Guangxi Cassava Ethanol and Starch Processing Factory utilise raw cassava for production of high value products.

Conclusions, recommendations, and way forward

RTCs are a key element in the traditional food system of PNG and the Pacific region. However, not much has been done in terms of R&D to give a competitive edge to the existing crops. NARI and other R&D institutions of the region should take into account lessons learnt from RTC development in countries like Brazil, China, Indonesia, Malaysia and Thailand. These countries have a high level of production which is supported by strong research programmes for RTC development. Efficient value chain pathways are backed up by appropriate government policies that create economic opportunities, and food security for citizens of these countries. The following recommendations are proposed as a guide for R&D organisations in PNG and other Pacific countries:

- R&D organisations are to invest in the value chain and end-user oriented research approaches, to support RTC-based agri-food enterprises of smallholder producers
- More research emphasis should be based on improving breeding strategies by integrating modern breeding tools for RTCs. Enhancing genetic resources will allow for the development of improved consumer preferred varieties, with climate resilience and added nutritional values (via biofortification)
- R&D organisations should embrace capacity building of RTC scientists and address critical gaps in RTC research and development agendas
- Attempt to invest in infrastructure development for RTC research and value addition
- Encourage and provide a platform for engaging a broad range of partners such as NARS, national programs, private sector companies and NGOs.

There are three main areas where RTCs can make an increased contribution to food security in PNG and the Pacific region:

1) There is considerable scope for improving the productivity of RTCs to increase food security of rural producers and contribute to their income. More research can be done on improving local planting materials and cultivation practices, if government policies redirect efforts to support the RTC projects of R&D institutions. Research will need to consider the differing requirements of the traditional production systems and the commercial sector.
2) RTCs and other traditional foodstuffs can make a contribution to improving the quality of the rural and urban diet. While such improvements can theoretically be achieved through other means, there are advantages in linking nutritional programmes with the production of appropriate local food items such as RTCs.
3) RTCs could have an important role in improving domestic cash flow and gross domestic product (GDP) in the region. There is scope for export of these crops to other countries of the Pacific region as well as worldwide. Substituting imported cereals with domestic starchy staples is also an option, however given the prevailing price advantage of cereals, is currently unlikely. The costs and benefits of promoting RTCs with a view to increasing income per capita and GDP in the region, need careful consideration before new policies and programmes could be devised. How would this compare with continuing to produce cash crop and other export products, while relying on imports for a significant proportion of food supplies?

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